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Enzyme Action in the Textile Industries*

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The main purpose of this paper is that of interesting the textile industries in a more comprehensive understanding of possible values that may accrue to them by a closer acquaintance with enzymes and their relation to some processes of manufacture, to mildews, etc., and more especially to their relation to the large and somewhat vague problem of improving textile fibers. To this end has been given (1) a brief historical résumé of the main facts, hypotheses and theories that have led to the name "enzyme" and to the classification and nomenclature of enzymes as used in the twentieth century; (2) a comparative study of amylase (diastase) from barley malt and fungi; (3) a brief statement of molds in cotton and wool goods and enzyme reactions; (4) a brief experimental study of possible practical uses of proteases such as pepsin, trypsin, papain, bromelin, korofor, serizyme and others in degumming silk in silk combinations with wool. It is shown that every indication leads to the conclusion that a competent knowledge of enzymes and their actions in processes of metabolism which are involved in vegetable and animal growth which must be carefully considered in any improvement of textile fibers, will be required of textile chemists and biochemists and a brief indication of training necessary is outlined.

Historical Introduction

A BRIEF survey of fermentation processes is perhaps the surest way of understanding the origin of the term enzyme and the various phenomena ascribed to enzyme activities. Fermentation processes in the preparation of wine, vinegar, beer and bread were doubtless known and practiced in prehistoric times as indicated by certain references in written literature. These processes were, in all probability, looked upon as mystery processes perhaps akin to life processes in the animal and vegetable kingdoms, but were not limited to action on animal and vegetable matter. The philosopher's stone of the alchemists was supposed to set up a fermentation in the baser metals which might develop a germ or essence or whatnot under suitable conditions, to be found by trial and error methods, that should transmute or purify them into one of the noble metals, gold or silver.

The first step to definite knowledge on fermentation may be said to date from the latter part of the seventeenth century when Anton von Leeuwenhoek, a Dutch microscopist, sent to the Royal Society of London a description and drawings of yeast cells as seen by means of his recently devised powerful magnifier. However, it was more than a hundred years later, 1803, before Thenard, a French chemist, stated that fermentation was caused by the yeast cell and it was some thirty-five years later before the work of a number of investigators had brought forth convincing evidence that the yeast cell was the originator of fermentation and the yeast plant was given the name *saccharomyces* (sugar-fungus).

Liebig very soon (1840) attacked the doctrine that fermentation was caused by micro-organisms and announced the theory that fermentation was due to mechanical decomposition of complex substances and stated that yeast was a lifeless albuminoid mass. This theory held sway by showing in a fairly conclusive way that fermentations and putrefactions were due to metabolism in micro-organisms. This vitalistic theory was followed soon afterwards (1858) by Traube's dictum that fermentation was due to different active principles (enzymes) produced by the yeast cell in its metabolic processes and not to the yeast cell itself.

However, the vitalistic theory still continued in favor and "true" ferments like yeast supposed to act by virtue of vital processes were called organized ferments in distinction from ferments like ptyalin, pepsin, trypsin, etc., which were considered as purely chemical products and called unorganized ferments. Much confusion arose over

*Presented at Annual Meeting, A. S. T. M.

this classification as Träube's idea though not conclusively proved continued to persist which led Kuhne in 1878 to propose a new name for the unorganized ferments. The name was "enzyme" of reek derivation meaning "in yeast" to insure including the unorganized ferments which were believed to be developed by the yeast plant. It was some twenty years later before the researches of Fischer, Buchner and others led to a convincing conclusion by an experiment carried out by Buchner (first published in 1897) in which he isolated from living cells a nitrogenous substance enzymic in character and which brought about identical fermentations without the presence of the yeast cells. He named the substance "zymase."

Classification of Enzymes

Most enzymes are soluble in dilute glycerol, sodium chloride solution, dilute alcohol and water and are precipitated by ammonium sulfate and absolute alcohol. They are mostly colloidal and act by catalysis. A textbook definition of an enzyme might be about as follows: An enzyme is an organic catalyst which is elaborated by an animal or vegetable cell and has the power of producing fermentation independently of the cells producing it. Buchner's zymase would be typical of the definition.

Each of the enzymes has an action more or less specific in character on which classification is based, that is, the action is specific as to the character of the substance on which it acts, usually termed its substrate. There are ten or more general classes, most of which are divided into several subclasses. The general classifications are quite varied, no two authors agreeing altogether, more or less on account of difference in point of view. There is more general agreement on the names in the literature which have as a first part an indication of the substrate and end in "lytic" or "clastic." As examples, amylolytic or amyloclastic enzymes are such as destroy or break down starches, dextrin, sugars, etc.; proteolytic or proteoclastic enzymes are such as destroy or break down proteins. To avoid confusion the endings "lytic" and "clastic" are now quite generally replaced by "ase" following Buchner's zymase, as amylase and protease for the above, and the subclasses under these would be called together the amylases and the proteases. Some of the amylases and proteases are the only enzymes which, with two or three bacterial ferments, have come into direct use in the textile industries, and in general to only a limited extent, notwithstanding that fermentation processes for the retting of hemp and for the degumming of silk have been in use for a long time. But these, like many other processes of the textile industries, have not been carefully investigated, it being only necessary to know that they work.

The best known and understood and most used enzyme in the textile industries is the amylase commonly known as diastase. It has been used under different trade names for a number of years for removing starch and dextrin from finished textiles but the optimum conditions of use such as temperature, concentration, pH value, etc., have not been carefully investigated so that there is no uniformity of practice.

Diastase is produced from germinating barley grains (malt-diastase) and from fungi. Taka-diastase is a trade name for diastase made from *aspergillus Oryzae* and has been perhaps more carefully investigated on account of its use as a pharmaceutical preparation for use in cases of amylotytic dyspepsia. Taka-diastase will convert one hundred times its weight of starch to maltose in ten minutes under favorable conditions which is much faster than the action of malt-diastase. Taka-diastase also produces a clearer and more liquid product than malt-diastase, which, however, may be due to other enzymes which have been found associated with taka-diastase. Amylases are produced by many fungi of the *aspergillus* and *Penicillium* types but none, so far as the author knows, produce them in quality proportionate to the taka-diastase produced by *aspergillus Oryzae*. Taka-diastase as a reagent for estimating starch sizing on cotton goods is compared to copper and iodine methods in an interesting paper in the *Journal of the Textile Institute*.[1]

A study of *aspergillus* and *Penicillium* molds sometimes spoken of as the green, black and yellow molds, though they are not the only molds of these colors, may be the most interesting studies for textile students as a means of becoming better acquainted with enzyme actions on account of their variety and their common occurrence in things relating to everyday life. The *aspergillus Oryzae* used in the production of taka-diastase is a yellow green mold. *A. flavus* is a yellow green mold found on preserves and jams in the home. *A. glaucus* is perhaps the most common green mold and *A. niger* is a very common black mold, both found everywhere, one might say. *Penicillium glaucum* is a green mold of somewhat different characteristics, but like *A. glaucus* it is found everywhere. *P. Roqueforti* is a green mold, the "ripening" agent of Roquefort cheese. *P. Camemberti* is a grayish white mold, the ripening agent of Camembert cheeses. *P. Italicum* is a blue-green mold found on oranges and lemons when rotting in storage together with *P. digitatum,* an olive green mold, and *P. expansum* is the storage rot fungus of apples and pears.

Fungi causing mildews in cotton goods are more often varieties of *aspergillus* and *Penicillium* than of other fungi. Identification of species of *aspergillus* causing mildew in cotton goods is given quite extensive consideration, including laboratory methods by Smith in the *Journal of the Textile Institute*.[2] The paper furnishes a quite considerable amount of information of interest to manufacturers and users of cotton goods and indirectly are useful to students of enzymes.

A very excellent paper on "The Fungi Causing Mildew in Cotton Goods" is written by L. D. Galloway, of the British Cotton Industry Research Association.[3] This paper takes up topics as follows: Occurrence of mildew fungi; source and extent of infection; methods of control; distribution of various types of mildew fungi (points

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Proceedings of the American Association of Textile Chemists and Colorists

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CALENDAR OF COMING EVENTS

Meeting, New York Section, Sept. 23.

* * *

Annual Meeting, Dec. 2 and 3.

SECRETARY'S NOTICE

The Secretary would be greatly obliged if he could receive information as to the present address of the following members:

Emory M. Fanning
Peter Graham
Alfred MacMillan
W. H. Turner
Karl Wille

At the present time we have no mailing addresses for the above names.

SYMPOSIUM, NORTHERN NEW ENGLAND SECTION

THIS is the report of a symposium arranged by Alex. Morrison and Clarence L. Nutting, and conducted at the Andover Country Club on Friday evening, April 8, with Alex. Morrison presiding.

The program began with a discussion of carbonizing troubles opened by Mr. Weber.

Carbonizing

Mr. Weber: One of the operations in the finishing process of wool is carbonizing, and since this process often leads to imperfections in the finished goods I thought its discussion a timely one. Whereas the methods of carbonizing are known to most of us, I am briefly outlining the two principal methods for the benefit of those present who may not be familiar with these operations.

Wool contains, in addition to fat and dirt, some vegetable matters which, in the case of new wool from the sheep, consists mostly of burrs and in the case of reclaimed wools also of cotton and other vegetable fibers.

All the processes for carbonizing are very nearly alike, in that some part of the reagent employed unites with some of the oxygen and hydrogen which go to compose the cellulose $(C_6H_{10}O_5)_x$, leaving a portion of the water of hydration in less stable combination with the other constituents, so that the material, when subjected to severe drying, loses both oxygen and hydrogen, becoming a friable hydro-cellulose which falls to powder when subjected to beating, shaking, or any violent form of vibration.

The two most commonly employed reagents for the purpose are sulphuric acid or aluminum chloride.

In the case of carbonizing with sulphuric acid the goods are immersed in a solution of this acid of a strength of about 5½° Tw.

In the case of aluminum chloride the goods are immersed in a solution of this product of a strength of about 9° Tw. It is commonly assumed that the action of aluminum chloride depends upon the fact that it is hydrolyzed, yielding oxychlorides and free hydrochloric acid, which destroy the vegetable matter like sulphuric acid.

$$Al\,Cl_3 + 3H_2O \longrightarrow Al(OH)_3 + 3HCl$$

The impregnation with the carbonizing liquor can be done either in the open width or in rope form in a washer.

Whether sulphuric acid or aluminum chloride has been used, the goods are extracted as evenly as possible, after they have been properly saturated, and are then dried at a temperature that is best under 200° F. The dry pieces are then baked at a temperature of about 220° to 270° F. It is during this process of baking that the destroying of the vegetable fiber takes place.

There is a third method used principally for carbonizing of woolen rags, which is known as dry carbonizing, and is done by the use of hydrochloric acid fumes in closed, heated chambers.

In the case of pieces thus formed hydro-cellulose is crushed by dry-milling the pieces. In the case of loose wool it is eliminated through a mechanical shaking process. Following the dry-milling the material is neutralized, in the case of sulphuric acid mostly with soda ash. When the aluminum chloride is used it may be done simply by rinsing with water or by treating with a hot hydrochloric acid solution, followed by neutralization with ammonia.

Some of the general precautions to be taken in carbonizing piece goods are:

1. That they be carefully freed from grease and soap before immersion in carbonizing solutions.
2. That the carbonizing solution penetrate the material completely and uniformly.
3. That on extracting the solution be so taken away that it leaves the material evenly moist.
4. Pieces should be dried immediately after extracting and not be let lie, as they will air-dry in places, usually at the folds, which causes them to become tender in these places.

I now wish to mention a few of the difficulties that I have encountered, which could be traced to carbonizing:

1. Pieces dyed after aluminum carbonizing dyed up cloudy. This was due to the fact that the water at the mill was hard and caused the precipitation of some of the soap on the goods, as lime soap, which afterwards combined with aluminum, forming an aluminum soap, thus acting as a resist. The difficulty was overcome by a more intensive scouring, with the addition of suitable assistant, thus insuring freedom from soap on the goods prior to immersion in aluminum chloride liquor.
2. The goods were covered with small holes. This was due to condensation in the dryer, which was operated at 220° F. It was overcome by installing a fan, which freed the dryer of moisture, and by reducing temperature to 200° F.
3. Mottled appearance of pieces dyed after carbonizing with sulphuric acid, which question I would like to leave open, as I know of no cure that will work in all cases.

Open Discussion

I would now like to hear from others regarding their experiences with this and other difficulties in connection with carbonizing.

Mr. Healy: I'd like to suggest that the trouble last mentioned might be due to the fact that the goods were unevenly extracted and that the temperature in the baker was too high. Where there is an excess of sulphuric, the goods might be darker in color and even have the natural condition of the fiber destroyed. Unevenness of the acid causes unevenness of the dyeing.

Mr. Derby: We had trouble with resist spots, and found that where the goods were hydro-extracted these resist spots showed up when goods were dyed after carbonizing. To remedy this, we painted the extractor with Duco, inside and outside of shell and basket, so that the goods didn't come in contact with the metal, and this eliminated all the resist spots.

Mr. Claflin: It always seems to me rather unsound to put goods after they have been carbonized either into plain water or into water containing an alkali to neutralize. I think a more logical treatment, due to the nature of the wool, would be to have them immersed first in a solution of common salt or Glauber's salt to wash out the acid.

Mr. Grady: I'd like to ask, Mr. Morrison, if there is any indicator with which you can determine freedom from aluminum salts after the carbonizing or rinsing?

Mr. Morrison: Mr. Healy should be able to answer that.

Mr. Healy: I don't know of any indicator that would show the presence of aluminum.

Mr. Christison: You can always tell rather readily in the case of undyed stock if the goods are aluminum free by a very short boil in alizarine or alizarine sulphonate. The aluminum shows very readily and the test is quite delicate.

Mr. Lane: I have a few questions on carbonizing. Say a 12-ounce fabric is immersed in sulphuric acid, what per cent of acid does that fabric pick up before it goes into

the dryer? After that, if one rinses the same piece in cold water, as some do for 20 minutes, how much sulphuric acid is left after the rinse? Then, presuming it is to be dyed with sulphuric acid colors, after the dyeing operation is complete and the piece is finished, how much sulphuric acid is left in that piece of goods?

Mr. Morrison: I think Mr. Lane has asked a mouthful.

Mr. Hobby: Mr. Winthrop C. Durfee told me several years ago that he had found from his work that there was plenty of acid left.

There is a patented wet sulphuric dip process without baking, which seems to destroy cotton very quickly, before any very visible injury to the wool occurs. A very considerable amount of acid stirred into water is used. The Durfee laboratory finds this a handy laboratory test, but has not tested the quality of the wool remaining. The dry sulphuric acid or baking process, with weak acid, subsequently dried and baked, seems to depend for success on sufficient ventilation. Good ventilation seems to permit lower heats and sometimes better color if silk is present, and poor ventilation seems to incur danger even to the extent of making wool soup.

Mr. Leitch: Some experiments that have been conducted to determine the figure Mr. Lane has asked for were founded on woolen goods of the weight of 12 ounces to a yard, 56 inches in width. The cloth carried about 7% sulphuric acid after carbonizing. That figure does not depend wholly on the length of immersion in the bath or the capacity of wool to absorb the acid, but depends largely upon the degree of extraction of the cloth after saturation. The amount of acid left in the fabric after the usual rinse in cold water is somewhere around 3%. Hot water would give about the same figure, that is leave about the same amount of acid. I have no figures on the amount of acid after dyeing.

Mr. Morrison: Does the amount of acid the goods absorb depend on the strength of the acid solution?

Mr. Leitch: I should say "Yes." The strength of the acid solution is determined largely by the amount of vegetable matter in the fabric and the length of time it is allowed to soak or go through the saturating bath.

Mr. Sampson: In one of the early editions of "Knecht, Rawson and Lowenthal," mention is made of some experiments conducted by Dr. Knecht on this question of sulphuric acid absorption by wool.

As I recall it he found a little better than 3 1-3% of Sulphuric Acid was retained by the average wool fibre, and even on prolonged washing only slight amounts were removed. As I recall it he brought the figure down to approximately 3% that could not be washed out.

Mr. Grady: Mr. Lane specified a 20 minute wash. Is that long enough? Is it the average length of time?

General opinion: Yes.

Mr. Derby: I may say that along that same line, by boiling woolen goods with as high as 10% sulphuric acid, I found the same percentage held in all cases. Where it was over 3% it would wash down to 3%. That would vary slightly with the grade of wool, but about 3% is held in the wool fiber whether you use 3% or 10% to boil it out. After you wash with successive portion of boiling water there is about 3% left in.

Mr. Morrison: While we are on this general subject of carbonizing, I have asked Mr. Ryberg, one of our research associates doing work at the Lowell Textile Institute, to come here tonight and outline what the Association is planning to do in connection with its study of carbonizing. He will give a general outline of the problems he is undertaking to solve, and after you have heard his remarks possibly some of you may offer some suggestions which the research committee may include in their program. I think it is a good opportunity for you to see Mr. Ryberg and know that we have at least one associate working for us in this territory besides the two in Washington.

Report of Research Associate

Mr. Ryberg: Up to the present time we have not engaged in active work on the process. The first or preliminary work consisted of a search of all the available literature on the subject of carbonizing, both the sulphuric acid process and the aluminum chloride process. The amount of worthwhile information was quite small. Most of the articles found were repetitions, giving a general outline of the carbonizing process, but practically no information of a fundamental nature concerning the difficulties encountered in this process and the remedies successfully applied. A few valuable articles relating to the absorption and retention of sulphuric acid by wool were found. This lack of knowledge concerning the fundamentals of the process seems rather surprising, when one considers that the carbonizing process with sulphuric acid has been in use for a considerable length of time.

Our next step was to design and build a laboratory apparatus in which the physical conditions would approach as nearly as possible those of a mill carbonizer. This apparatus consists of a medium sized insulated chamber, inside of which are placed two rotors in the shape of pentagons. These rotors are attached to a central shaft, which holds them in the middle of the chamber. The shaft is rotated from the outside of the chamber. The samples, ten in number, are hung from the outer edges of the rotors and between them, in such a way that when the rotors revolve the samples will always hang in a more or less vertical position. Thus the samples will all receive the same treatment. A steam coil will probably be used as a heat generator. The temperature will be controlled by thermometers, as well as the rate of flow of the air.

Since the sulphuric acid process is the one most used today, it will be the one to be first investigated. It is our intention to experiment with different strengths of acid, say from 3° Tw. to 8° Tw. to find which concentration gives maximum carbonizing efficiency with minimum destruction of the wool. Varying temperatures and rates of drying and baking will be studied in relation to the strength of acid used.

The use of wetting out agents in carbonizing may be investigated.

The so-called resist spots seem to be encountered by practically everyone who is doing carbonizing. Some attribute them to one cause, some to another. Various remedies have been applied and have corrected the situation, but just why no one seems to know. Again, the same remedy does not always work.

It is our intention to investigate these resist spots in an attempt to understand their occurrence and possibly find ways of permanently correcting them.

Mr. Derby's reference to the results obtained when the goods are extracted in a basket extractor, leads me to think that there might be an oxidation brought about when the material is in contact with the bare metal, and the extractor is moving at a high speed. The metal might possibly act as a catalyst and speed up the oxidation at isolated places on the material and these would then show up as resist spots upon dyeing. Ducoing the extractor would naturally keep the material from coming in contact with the bare metal and thus prevent these resist spots.

Any suggestions offered will be gladly received.

Mr. Derby: In continuous carbonizing, you can make resist spots by allowing the goods to stop over the vacuum extractor without shutting off the vacuum. Apparently, drawing the acid off that one spot will leave a resist spot.

Mr. Sullivan: I'd like to ask the members if they have any opinion as to the best temperature, both for the sulphuric acid and the aluminum chloride.

Mr. Derby: I suppose the room temperature is the best.

Mr. Healy: I don't know definitely, but in general, if it is possible to run a higher temperature you get better penetration. This may bleed colors. I do not know any way of predicting what dyes will bleed, and I do not want to say that aluminum chloride will not affect any dyes, but it should be possible to run higher with aluminum chloride than with sulphuric acid on account of its milder action.

Mr. Christison: In regards to a remark about resist spots being caused by the goods standing still over the vacuum slot and sucking the acid out, our experience is that the resist spots are not caused by the vacuum sucking acid out but by the vacuum sucking acid in. The tendency is for the goods to dry over the slot, the cloth acts like a wick, and the acid keeps moving toward that place. It is our opinion that the resist is caused by excess of acid rather than the absence of acid.

Dr. Chapin: It is quite likely that similar action occurs in the dryer, acid migrating to points of more rapid drying. T. K. Sherwood summarized in Industrial and Engineering Chemistry for February, 1930, a series of experimental and mathematical studies on the "Drying of Solids," which seem to have a direct bearing on this stage of carbonizing. He found that the drying of a solid divided itself into two stages, in the first of which evaporation from the wet surface depended not on water content but on air velocity and other factors in the surroundings. During this period he found that the rate of drying remained fairly constant so long as these surrounding factors were constant. Then in the second period he found the drying rate decreasing as wetted surface diminished, or diffusion from the interior of the solid became the controlling factor.

It would seem that speed and uniformity in the first stage of drying is vital to uniform carbonizing, and that it is to be attained, after even extraction, by adequate velocity of air at proper temperature and humidity.

Mr. Sampson: In regard to the point Mr. Claflin brought up, rinsing the goods in a Glaubers Salt solution —that being patented in England—there is a concern here in New England that has been doing that for the last 15 years and doing a good job in carbonizing. I think that would be a good point for our committee to study. I think I can go over that with Mr. Ryberg and follow the process right through.

Mr. Morrison: Here is a question.

What is the fundamental reaction that takes place when carbonizing with Aluminum Chloride?

Reaction Taking Place During Carbonizing with Aluminum Chloride

In the literature it is stated that Aluminum Chloride reacts during the baking, liberating Hydrochloric Acid, which attacks the vegetable matter, disintegrating same. While this reaction probably takes place, there are a number of indications that it is not the basic reaction.

Is it not possible that the Aluminum Chloride, having such an affinity for water, will take it from the combined Hydrogen and Oxygen in the vegetable matter, causing the vegetable matter to disintegrate in the same manner that the vegetable matter is disintegrated by Sulphuric Acid carbonizing?

Aluminum Chloride does have such an affinity for water that it will take the combined Hydrogen and Oxygen from certain organic compounds, this being the basis of the Friedel and Crafts Reaction used so frequently in organic chemistry, an example which is the production

of Anthraquinone from Phthalic Anhydride and Benzol.

Mr. Healy: I would like to say in the first place that I don't want to argue whether the reaction is due to dehydration or to hydrolysis. I do think that there is very good evidence that the reaction is not due to the formation of anhydrous aluminum chloride as has been suggested. In the first place, a survey of the literature indicates that this could not be so. I have several very good references here and they all say the same thing. One man says, "The aqueous solution loses hydrochloric acid when evaporated, particularly at elevated temperatures, and if the evaporation is carried to dryness, a basic product is formed which is completely soluble in water, and with repeated evaporation much alumnia or aluminum hydroxide is formed."

Another reference. "The crystals do not melt when heated but give off water and hydrochloric acid leaving 21.6% of aluminum oxide as residue. The anhydrous chlorides cannot be obtained by heating the hydrated salts." This indicates complete decomposition of the aluminum chloride as theoretically the percentage residue should be 21.1. Obviously, if anhydrous aluminum chloride is formed as an intermediate product, the alumina content of the residue would be much lower as the aluminum chloride is of itself volatile.

Another man says, "Above 260°F. in air, water and hydrochloric acid are simultaneously evolved from aluminum chloride." So much for the literature.

Experiments carried out in our own laboratory also indicate that there is no intermediate formation of anhydrous aluminum chloride. Anhydrous aluminum chloride sublimes at 360°F. which is of course much higher than a normal baking temperature. In studying the decomposition of crystal chloride of alumina at baking temperatures of 240 to 260°F., one would expect then, if anhydrous aluminum chloride is formed, that the crystal aluminum chloride would lose its water of crystallization and decomposition would cease. The extent of the decomposition in this case would be no more than 45%. We have found in the laboratory that a 70% decomposition can be obtained in normal baking time and at ordinary baking temperatures. If the reaction is carried out for a long enough time, 11 hours, a 90% decomposition may be realized. The curve indicating the rate of decomposition is a smooth one, and shows no flat points such as one would expect if anhydrous aluminum chloride were formed. Of course it may be argued that anhydrous aluminum chloride has an appreciable vapor tension at these temperatures and is volatilized at the same rate as the water of crystallization is driven off. Analysis of the residues, however, and comparison of the alumina to chloride ratio, shows that this is not so and that the reaction is, as indicated in the literature, one of decomposition of the aluminum chloride, and no anhydrous aluminum chloride is formed as an intermediate compound.

Dr. Chapin: You find that the bath becomes less acid?

Mr. Healy: Yes. The aluminum chloride seems to have a preference for picking up the acid in the bath rather than the aluminum. My own experience shows that the bath reaches a constant excess of alumina over that theoretically required by the proportion of the formula. Now, that is only a single experience, and this depends a lot on the condition of the wool. Wools containing alkali will kill more acid than wools which have been thoroughly rinsed. I would like to know what takes place in the baker with aluminum chloride. If we assume that hydrochloric acid is the active agent, does the carbonizing take place in the liquid phase or does it take place afterwards in the gas phase? It seems silly to assume that with the carbonizing agent right in contact with the goods it has to volatilize to a gas and then carbonize. On the other hand, if it will do that, it means that penetration is not necessary, and that you simply have to get aluminum chloride on the goods somewhere so that it will volatilize in the baker.

Dr. Chapin: Whatever happens in the baker and dryer, it is pretty evident what happens in the bath. Aluminum chloride in water hydrolyzes slightly, forming hydrochloric acid and aluminum hydroxide. Wool absorbs the acid and hydrolysis continues, producing as much acid as the wool can absorb.

Mr. Healy: Of course, hydrolysis does take place in the solution, which is usually in the neighborhood of pH 2 to 3. As I say, it is anybody's guess what takes place in the baker. I think it is an important point and should be cleared up. It may throw some light on the amount of acid in the goods leaving the baker. We find that almost 2%. The ordinary understanding is that the carbonized goods can be neutralized by rinsing in water. If you are not going to neutralize in any other way, give them a rinse in water. There is always some left which may react and give trouble in dyeing.

Mr. Leitch: Before dismissing the subject, I just want to call attention to one other method of carbonizing, not as regards the acid used, but the condition of the material when it goes into the bath. Mr. Weber states that the grease should be removed, but many mills carbonize in the grease. Carbonizing is quite possible in the presence of the ordinary amount of grease in the woolen or worsted goods. The principal drawback with that method is that the grease-smoke in the dried and baker causes some difficulty unless it is taken care of in a very efficient way. The advantage of carbonizing in the grease on woolen goods is that large burrs are removed before there is any felting action given, and in that way the finished fabric is sometimes smoother and better than it is if carbonized after fulling and washing.

Dr. Chapin: Too little attention is given to proper distribution of acid in the bath. The necessity for good distribution becomes apparent immediately upon installation of an automatic recorder-controller for acid, but it exists none the less in the absence of automatic records and control.

I have found it convenient to introduce acid through a lead pipe running down a corner inside the tank at the end where the goods enter, then across the end well beneath the liquor level and up a trifle in the other corner. I have had the pipe perforated across the bottom, and have left the upturned end open to guard against overflow from the funnel at the entrance end of the pipe in case the perforations should plug with flocks. For agitation I have used an air pipe just beneath the acid pipe, with perforations on its under side, away from the acid.

In determining the amount of acid carried by the goods into the dryer, the concentration would seem of most importance in the exit end of the tank. For this reason it seems logical to discharge water pipes and drains from the extracting system into the opposite end, behind the entering goods.

Mr. Weber: Coming back to aluminum carbonizing. That is being corrected by the addition of hydrochloric acid to the aluminum chloride bath.

Mr. Healy: Yes. It can be corrected but it doesn't have to be. I think the free acid bath tends to discolor. If you try straight hydrochloric acid with white wool, you get a pink coloration sometimes going over to brown. Of course, to replace acid removed by wool muriatic acid is added to the bath.

Mr. Morrison: What good are penetrants in carbonizing? There ought to be some Tensol salesmen around here.

Dr. Chapin: Hasn't Mr. Healy's "Inhibitor Acid" some wetting-out ability?

Mr. Healy: It doesn't compare at all with the common wetting-out agents on the market. I'm interested to know about wetting-out agents as most of the literature indicates that wetting-out can be carried out in a matter of seconds. I think that is far fetched. It is outside of mill practice. There is no carbonizing operation that I know of where it is necessary to speed the immersion operation to such an extent that it should be carried out in a few seconds.

Mr. Morrison: Perhaps Mr. Fortner can say something on penetrants.

Mr. Fortner: The only thing I can say would be that a penetrant lowers the surface tension so you don't get local absorption of the carbonizing liquor in one spot and not in the other. In other words, you won't get a spotty reaction on the goods.

Mr. Morrison: This discussion has been interesting but I guess we'll have to change the subject.

Cause of and Remedy for Tendering When Dyeing Cotton Yarn with Sulphur Black

I have here a question which I gave to Mr. Moorhouse to answer. He had to leave, but he has left a typewritten answer and we'll be glad to have any discussion in regard to his answer.

The question is, "I am dyeing cotton yarn in packages with Sulphur Black. After dyeing the packages are washed several times with warm and cold water with acetate of soda in the last rinse. The yarn is then alkaline to phenolphthalene and litmus. After drying for 12 or 15 hours at a temperature around 220° F. the yarn is neutral to the same indicators. What becomes of the alkali?"

Mr. Moorhouse: Cotton dyed with Sulphur Black and rinsed as per method given will undoubtedly retain a small amount of Sulphide of Soda, and therefore give an alkaline reaction. During the drying of the dyed cotton the Sulphide of Soda is oxidized to Sodium Sulphite and Sodium Thio-sulphate is therefore no longer alkaline.

There is a large amount of evidence that indicates that the Sulphur Black molecule can absorb a certain amount of Sodium Sulphide, which is probably chemically combined with the Sulphur Black molecule. This Sodium Sulphide is probably loosely held, but it requires an abnormal amount of rinsing to remove it entirely. It has been my experience that it is advantageous to leave small amounts of Sulphide of Soda in the cotton. This acts as a stabilizer, causing a slow oxidation of the Sulphur in the Sulphur Black molecule. When this slow oxidation takes place the cotton usually does not tender on storing. However, Sulphur Black dyed material that has been given an abnormal amount of rinsing is very likely to become tender on storing, due to the fact that the last traces of Sulphide of Soda have been rinsed out and the Sulphur in the Sulphur Black molecule is then in a position to be rapidly oxidized, which causes tendering.

It has also been the writer's experience that another way to guard against tendering is to aftertreat the dyed and rinsed cotton in a boiling bath of Bichromate of Soda and Acetic Acid. Such aftertreatment probably oxidizes most of the loosely combined Sulphur in the Sulphur Black molecule, the sulphur oxidation products formed being washed away during the subsequent rinsing. Therefore there is nothing left in the Sulphur Black molecule to cause tendering on storing.

The Value of a Kier Oil

Mr. Morrison: The next question is "When, if ever, is a kier oil necessary? If not, how low can other extractibles be reduced with an unassisted caustic boil?"

Mr. Moran will answer this question.

Mr. Moran: The question seems to imply some doubt on the part of the questioner as to the value of the various kier oils that have been impressed upon us in the last few years, at least as to their benefit for this purpose. Bleaching is a rather old procedure, highly developed, quite efficient, and not very expensive, but quite slow as it has been conducted in years gone by. When I started in business, the lime boil was in general use. This necessitated two boils, the first with Lime and the second with Soda Ash. However, at that time, there was available another process which happened to be in use where I started in. That process was based upon an investigation conducted by Prof. Knecht in England, in which he developed the fact that when cotton was boiled with Caustic Soda, relatively little of the cotton wax was removed, perhaps, 30%, whereas if it was boiled with Soap, around 60% would be removed, and if boiled with Rosin Soap around 70% removed. And, on this basis, a single boil with Caustic Soda, together with Rosin Soap, under pressure or 10 hours, was adequate to give a satisfactory bleach, at least appeared to be satisfactory at that time; and that is apparently more or less the basis of the more recent procedure by which kier oils have come into use. I assume something of the nature of a Sulphonated Oil, Soap, Rosin Soap, Pine Oil mixture or some of the various wetting out agents which have become available in recent years, are referred to in the question. Since around 1900, Caustic Soda has greatly increased as compared with Lime for kier boiling. The fact that it is soluble and can be more easily handled, and Lime stains avoided, has tended to increase its use, and as it has come down in cost, the objection to the higher cost has been overcome. Originally, of course, Lime was plentiful and inexpensive and the whole procedure quite inexpensive. As long as no particular hurry was necessary in handling the goods, two boils were continued, even with the Caustic boil. Most plants had been equipped for Lime boils and so had ample capacity for the double boil. As the kier charge was split between the two boils, not much extra cost was involved and it assured a uniform treatment. So, if the circulation failed to be unform in the first treatment, the defect was certain to be overcome on the second boil. The first boil removed most of the foreign matter and dirt and the second gave a relatively clean boil. During the last ten years, pressure has come upon mill people for increased speed in production. Speed has become important in getting deliveries out on time, and in consequence, there has been a marked increase in the use of the single boil, so that now the single boil is quite largely in use. In kier boiling, the goods may be put in by hand or by mechanical means. Where they are hand plaited there is a good deal of uneven packing and uneven circulation. With mechanical plaiting, these defects are less marked. But there is always the liability of uneven circulation and some of the goods may come out without getting adequately boiled. Anything that increases the absorbency tends to reduce this liability to uneven circulation, and the main advantage in adding something of the nature of these kier oils is to increase the absorbency and wetting-out qualities of the cotton, thereby increasing the speed with which the kier charge begins to act on the goods, and allow considerably more efficient boiling in a given length of time. Goods that are boiled in the kier are so handled for various purposes, and, a great variety of cloths naturally are handled. Some of them, of course, are soft and readily wet out, and it is comparatively easy to secure adequate penetration and circulation. Others are hard twisted, or, made from yarns that resist penetration. Some goods are boiled simply for finishing white, while others are for prints, and still others for plain shades. The requirements for white work are much less severe as regards the boil. Uneven boiling will not show particularly on goods that are finished white. On goods that are to be printed, the patterns are broken up and most of the print colors are relatively easy to be absorbed by the fabric, so that an uneven boil may not be so serious a defect in the case of prints. But, in the case of plain shades, the difficulties may be much greater, depending on the character of the dyeing and on the character of the cloth. If the cloth is to be dyed with direct dyestuffs and it is relatively soft, little difficulty may be experienced; but with finer goods, higher counts, harder twists, combed yarns and particularly if the goods are to be dyed with vat colors, and especially on range dyeing, a great amount of difficulty may be experienced unless the goods are absolutely perfect as they come out of the kiers, as regards absorbency. So, it is advisable, under those conditions, to favor the goods as far as possible. Cost is a consideration on all cotton goods, but on finer goods and goods that are dyed with vat colors, where the cost is of less consideration, you can afford to stand a somewhat higher bleaching cost. The question as it is asked is if kier oils are necessary. It might be better to put it, "Are kier oils advantageous, advisable or expedient?" I don't believe they are necessary, but in some cases it seems quite desirable that some addition should be used, particularly on the single boils, to help the wetting out and penetrating of the kier liquors. Cotton, as it is plaited into the kier, is coated with quite a considerable amount of foreign matter, and particularly a certain amount of cotton waxes. These cotton waxes are quite repellent to water, and unless some assistance is given, the wetting out becomes a slow operation. As the boil starts, the Caustic Soda usually acts on the fatty acid that may be present. Probably some oils, in the nature of Cotton Seed Oil, are saponified and converted into Soaps, and these Soaps exert a wetting out action and gradually

wet out all of the fabric that is in the kier, but naturally this is much slower than if you give it assistance at the start by adding some assistant that will bring about this wetting out in a much shorter time. So, I believe that with the single boil, there is an advantage, with certain classes of fabric, from adding some sort of kier oil to your boil. One of the products that has been advocated during recent years has been Pine Oil. And, of course, there have been others, such as the hydrogenated hydrocarbons that are of a more or less oily character, or, liquids not mixable with water. These, in order to be usable, require to be mixed with emulsifying agents, such as Soap or Sulphonated Oil that will cause them to emulsify and mix readily with water. The idea presumably of the Pine Oil is that it dissolves the cotton wax, but the amount used is so small that it is a question if the solvent action is not due mainly to the Soap or Sulphonated Oil that is used as an emulsifying agent along with the Pine Oil or similar product, rather than the Pine Oil that is present. The rapid wetting out of the cotton fibers and the uniform circulation throughout the kier, seem to be the main purpose desirable to accomplish.

Mr. Morrison: The next question is, "Of how much importance is the 'titre' of a soap? When and where are high titre soaps preferable, and when and where low titre soaps?" Mr. Leitch has an answer for this.

Importance of Titre of a Soap

Mr. Leitch: I think perhaps this committee picked my name out of the hat, then when they did, they let it go through with the hope I'd say something to get some of you men to tell us the answer. So I considered the question and will give you my idea on the subject. Considering only the use of soaps on woolen and worsteds, the following ideas are offered. Some of the ideas that influence the finisher's judgment in selecting the soap are whether the cloth is woolen or worsted; the kind of oil used in the preparation of the yarn; the weight of the fabric; the amount of felting permissible or required; the necessity for keeping the alkali content low, that is, in the soap solution; the need for economy in fulling; the need for economy in washing, such as saving hot water; quantity and nature of the sizing material used in the fabric on the warp yarn; and nature of the processes preceding the fulling or washing and succeeding the washing. Soaps having the same titre would not necessarily have the same properties or act in the same way when used in either fulling or washing. I thing that for heavy fulling of woolen goods, and worsted goods too, practically any soap can be used. In the fulling of light weight goods, I doubt if the heaviest or highest titre soaps could advantageously be used. And in the washing of woolen and worsted fabrics perhaps only the lowest titre soaps can be used on some fabrics where felting is undesirable. My own guess in regard to whether high titre or low titre soaps are preferable has changed from time to time. I think that I will give you my present idea, and that is that the low titre soap can be used for practically any fulling job or any cloth washing job except on fabrics which ordinary soap cannot be used at all. I believe that by using a sufficient quantity of low titre soap the heavier fulling jobs can be done. But very possibly the high titre soaps would be somewhat cheaper to use. I believe that gives my view on this question.

Mr. Morrison: Any one else have any remarks on this soap question?

Mr. Hobby: Does the soap act merely as a lubricant or is it a felting agent? What is the reason that a high titre soap is desirable? Is it because it lubricates the fiber, or does it affect the felting?

Mr. Leitch: I don't think I can give a positive answer on that question, but the question of fulling is not wholly a matter of lubrication because acid fulling is in fact very largely practiced, particularly in the manufacture of hats and mechanical felts. You would hardly class sulphuric acid as a good lubricant.

Mr. Morrison: Any further remarks? If not. here is another question.

If one skein of worsted yarn is dyed under strong tension and another skein dyed without tension in the same bath, will there be any difference in the depth of shade? If so, which will be the heavier? If dyed in separate baths, will there be any difference?

Worsted Yarn Dyed With and Without Tension

Mr. Bell: We often dye yarns right in the same bath with tops, and the yarn will come out a darker shade than the tops, even if made out of the same stock. That is, the yarn with tension dyes darker than the top without tension.

Mr. Claflin: It seems to me that same question may have a bearing in piece dyes where the different yarns in fabrics may be under different tension. Whether that would cause some of the dyeings with the center shaded as is found in piece dyes or not I do not know. The fact that the yarn with tension dyed heavier than the yarn without tension might explain some of the difficulties found in piece dyeing.

Mr. Morrison: If it is suspected that there are lime and magnesia soaps on woolen or worsted piece goods, what is the best method of removing them before dyeing? Mr. Gile.

Lime and Magnesia Soaps and Their Removal

Mr. Gile: I do not believe I can answer that question tactfully. It is my opinion that these insoluble soaps

cannot be removed by practical procedure, with the possible exception of employing certain well known products that have been brought out recently for this particular purpose.

I do, however, believe that the elimination of these insoluble soaps comes best through prevention. Provided the water contains magnesium or calcium salts, it is best to carbonize the goods in the grease or after dyeing. The reason for this is, these insoluble soaps when broken down in the carbonizing procedure form fatty acids, which no doubt are more detrimental to level dyeing than the insoluble soaps.

Some time ago, I was called upon to assist in the dyeing of goods composed of uncarbonized wool and shoddy, which was made from paper mill felts. These paper mill felts are heavily laden with aluminum salts and no effort had been made to remove them before scouring. Therefore, considerable aluminum soap was formed. These goods, dyed before carbonizing, in a bath containing sulphuric acid and level dyeing acid colors, showed a great many resist spots. Pieces prepared the same, dyed with the same colors in sulphuric acid but with the boil increased to 2½ hours, were practically free from these resist spots. Carbonizing these goods in the grease, eliminated all preparing and dyeing difficulties.

Mr. Morrison: Evidently Mr. Gile wishes he were selling Igepon.

Mr. Dalton: Pulled wool, containing lime soaps in the fiber, can be cleaned by precipitating the calcium as carbonate with soda ash.

Mr. Claflin: I know of a place where they suspected they had these insoluble soaps, in fact, the laboratory found them afterwards. They said they had tried various sulphonated fatty alcohols and they hadn't done any good. They were going to boil out the goods with 5% muriatic acid.

Mr. Morrison: The next question concerns:

A.A.T.C.C. Tests for Fastness to Washing of Dyed Cotton

Regarding soap test from the commercial standpoint, is there not a tremendous difference between the A.A.T.C.C. Soap Test No. 2, to % Soap and to % Soda for 30 minutes at 160° F., and No. 3 1/10 % Soap and no Soda for 30 minutes at 120° F.? Do the commercial cloth buyers use these tests for cotton goods, or do they have a longer range and many tests between these two points?

Is there anybody present at the meeting having experience satisfying the requirements of the buying of cotton cloth who can give any sidelights on the subject?

Do big buyers such as Sears, Roebuck & Co. and large department stores have men to test such colors and specifications?

Dr. Chapin: As regards Sears, Roebuck, there is an article in a recent number of the DYESTUFF REPORTER by a member of their staff.

Mr. Smith: I know a mill where their colors stand test No. 2 and they sell their goods as tub-fast.

Mr. Morrison: The majority of developed colors seem to stand up all right. Some do not.

R. H. Macy & Co. writes, "We do not use test No. 3 for cotton goods. We do employ tests similar to tests No. 1 and No. 2 but with the following modifications: our 'B' test is exactly the same as test No. 1; our 'O' test is similar to test No. 2 except that we do not aftertreat with acetic acid."

Prof. Olney: In further answer to the above question it could be said that there not only should be but is a marked difference between the action of tests Nos. 2 and 3 of the A.A.T.C.C. Alternate Method for determining the fastness to washing and soaping of dyed cotton goods.

Dyed material which withstands test No. 2 but does not withstand test No. 3 is usable for only a limited number of purposes, while material satisfactorily withstanding test No. 2 may commonly be used where any amount of reasonable and careful washing is applied, and probably corresponds to much of the material on the market designated as wash fast.

Material which will withstand test No. 1 represents the highest type of fastness which can be guaranteed for any type of washing that will not injure the fabric itself.

The Launder-Ometer Method should, however, be given preference over the Alternate Method.

The A.A.T.C.C. Standard tests are constantly being used by an increasing number of manufacturers, retailers and customers and where modifications are made they are for the most part to satisfy some special condition rather than to change or modify the standard which has been set up by the Research Committee of the Association.

Mr. Morrison: Someone asks, "What progress has Meta Silicate made in the scouring of wool? If it is used at all on a large scale in this operation, what has been found the best procedure?"

Meta Silicate in Wool Scouring

Mr. Heath: We did a little experimental work to determine the effect of solutions of meta silicate on wool, and found it perfectly possible to discolor and tender the wool at concentrations which it would be quite easy to get, through error, in the mill. This is exactly what one would expect from the relatively wide range of pH which solutions of this alkali give. We also found that passing successive samples of greasy wool through a bath containing soap and meta silicate lowered the pH of the bath just as rapidly as when the alkali in the bath was soda-ash. Thus apparently the meta silicate is rather dangerous to use in a wool-textile mill in unskilled hands, and offers

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Proceedings of the American Association of Textile Chemists and Colorists

Tensile Strength and Elongation of Rayon

BY THE RAYON SUB-COMMITTEE*

Need and Value of Rayon Tensiles and Elongations

THE Rayon Sub-Committee has devoted a considerable amount of thought and attention to the method of determining rayon tensiles and elongations found in this report primarily because the Committee recognizes and wishes to herein outline the value of properly made and intelligently interpreted tensile and elongation determinations.

Variations within individual shipments from one manufacturer, from shipment to shipment of one manufacturer, as well as variations from manufacturer to manufacturer are often reflected in, and may often be determined by, accurately made tensile and elongation determinations.

The effect of varying tensions during fabric manufacturing operations on the uniformity of the finished product is so generally recognized throughout the industry that the subject need not be elaborated upon in this report. However, the Committee wishes to take this opportunity to stress the value of tensile and elongation determinations, particularly the wet elongation figures, as a tool of value in isolating the cause of lack of uniformity in finished manufactured fabrics.

Single Strand Test Most Illuminating

Whereas multiple strand tests will, of course, show differences from unit to unit the value of these (multiple strand) tests are very limited when compared with the information that may be obtained by the single strand tests. Differences within individual units that pass unnoticed when the units are tested by the multiple method are readily detected and clearly proven by the single strand test. Individual faulty yarns found in manufactured fabrics, warps, and etc., can be examined and compared with normal yarns from the same fabric by the single strand method of yarn examination. The above items have been enumerated here by the Committee with the thought that the value and scope of our tests given below may thereby be enlarged.

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Wet Tests Most Trustworthy

Many mills do not avail themselves of the knowledge that may be derived from tensile and elongation examinations because they cannot, or believe they cannot, afford the expense of a constant humidity room. For such mills, we recommend the wet method of testing which is accurate within the limits of the machines available, under all humidity conditions. The lack of a constant humidity room should not prevent any mill from enjoying the benefits to be derived from properly made tensile and elongation determinations.

Even to mills possessing constant humidity rooms we recommend unqualifiedly close adherence to wet tensile determinations, partly because we have found the wet strength of rayon is in our opinion much more important than the dry strength.

Method of Determining Wet Tensiles and Elongations of Rayon

The method of determining the dry tensile strength and elongation of rayon is with certain obvious modifications, so similar to the method of determining the wet tensiles and elongations of rayon and is so unreliable when "standard atmosphere" conditions cannot be maintained that the dry tests will not be discussed in detail here.

The method of wetting samples for the wet test has been the subject of so much discussion and controversy

that the Committee feels a discussion of the subject is necessary here. Three distinct methods are in use today:

(1) Place dry yarn in machine, wet one spot with camels hair brush, release tension.

(2) Place dry yarn in machine, wet entire length of yarn, release tension.

(3) Emerse yarn in water, place in machine, release tension.

The first method described above is a less drastic test than the other two as only one small spot in the entire eighteen inches is subjected to the test. Obviously, weak spots in yarn otherwise normal will not be readily detected by this method.

The exponents of the second method described above, claim that this method measures the total wet elongation and is therefore correct. We feel that the figure obtained by the second method is a resultant of two elongations. First, the elongation due to the swelling effect of water on rayon; second, the elongation caused by the application of tension to the wet yarn.

We feel that the third method, whereby the previously wet yarn is placed in the machine, in the usual manner, after which tension is applied, is the correct way to obtain wet elongation figures comparable in every way with the figures obtained when yarn is tested dry and figures that represent, as we feel they should represent, the elongation caused by the application of tension to wet rayon.

Details of Method of Determining Tensiles and Elongations of Rayon

In the interests of uniformity (from plant to plant) and accuracy, we recommend adherence to the following details:

(1) *Type of Machine*

Single strand machine operated by the "dead weight in oil" principle, by motor or hydraulic pressure.

(2) *Distance between Jaws*

Eighteen inches.

(3) *Placing Yarn in Machine—Retention of Twist*

Care should be used that the twist present in the yarn as received is not changed in any way while the yarn is being wet or placed in the machine. If the yarn is received on a spool, cone, pirn, or other similar "put up" the yarn should be removed from the package by rotating the package on its own axis rather than by drawing the yarn over one end of the package. Twist can be retained during the wetting operation by removing yarn from the spool, cone, or other device on which it is received, in the form of a loop, both ends of which are held while the yarn is "wet out" in a suitable container. In the case of highly twisted yarns, that tend to kink, a large shallow dish, such as a wash basin, can advantageously be utilized.

(4) *Method of Applying Tension to Yarn*

Tension is applied by hand—the tension being just sufficient to take up any slack that may be in the yarn. In the case of 150 denier rayon, apply less than two grams total tension. The use of weights for the application of uniform tension is recommended when the accuracy of the work is open to question—for example, in legal work.

(5) *Speed of Movable Jaws*

Twelve inches per minute.

(6) *Number of Determinations Necessary to Obtain Fair Average*

Ten

(7) *Method of Reporting Results*

Report elongation in percent increase over original length.

Report breaking strength in terms of grams per denier.*

*Note—Denier should be determined on length of yarn taken as near as possible to the yarn actually used for the tensile and elongation determination.

Symposium, Northern New England Section

(Continued from page 563)

no special advantage over soda-ash in the matter of maintaining, without additions, a pH suitable for efficient scouring.

Mr. Sampson: I was talking the other day with a wool scourer who has been experimenting with meta silicate. He said he had been getting very good results with it. I don't know what his procedure was.

Mr. Morrison: "What new developments have there been in vigoreaux printing paste formulas in the last few years? What is the best and cheapest means of bleaching stock?"

Mr. Sampson: Sulphur dioxide is the cheapest.

Mr. Claflin: Peroxide is the best and the permanganate in between. Permanganates have always been a neglected bleach. Sulphur dioxide bleach or any of the modifications are cheaper but not permanent.

Mr. Bell: Down in Malden we have been using Spot Pond water. They treated the pond with copper sulphate and we had a lot of trouble with our dyeings. If they do it again what precaution could we take to protect our dyeings?

Mr. Claflin: Store the water in iron tanks and the copper will come out.

Question from a few men: How about the iron? Laughter.

Mr. Morrison: Try thiocyanate.

STANDARD SILK SAMPLES

There have been prepared, under the direction of the Sub-Committee on Fastness of Dyed Silk, standard dyed silk fabrics to represent four classes of fastness to washing—namely, Class I, Class II, Class III and Class IV. These standards have been carefully dyed with the dyestuffs and according to the dyeing methods recommended in the 1931 Year Book.

The A. A. T. C. C. is prepared to furnish sets of these washing standards for a nominal charge which will cover the cost of preparation. It will be possible to accurately grade the fastness to washing of any dyed silk fabric by comparing it with the standards after subjection to the standard washing tests approved by this Association. All inquiries concerning these Silk Washing Standards may be addressed to the Chairman of the Research Committee,

Louis A. Olney,
Lowell Textile Institute,
Lowell, Massachusetts.

AMERICAN DYESTUFF REPORTER

Devoted to the use and application of dyestuffs and the mechanical equipment incidental thereto

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GENERAL ADVANCE SEEMS INEVITABLE

HIGHER prices on finished goods of all kinds are being put into effect more generally as manufacturers realize the full import of the striking advances that have taken place in textile raw materials and in many basic commodities. A sensational further rise in raw silk just recently brought 78 per cent 13/15s to a new high of $2.05. Higher raw wool and worsted yarn quotations are responsible for a firmer price situation in general. It is believed only a matter of a relatively few weeks before higher raw material prices are reflected in advances on practically all lines of goods.

There is nothing artificial about this rising trend in finished goods prices. Indeed, the really remarkable feature about the trend is that it has developed so slowly. Every decline in raw materials during the last three years was almost immediately reflected in the prices of the finished product, yet two months after the rise in silk, as an example, got under way, many mills have still to move their prices up even a slight notch on silk hosiery. After years of declining prices manufacturers have been under psychological as well as physical handicaps in getting their prices up in line with the raw material climb. Extremely distrustful of one another, and fearful of losing business to a competitor, they have been ultra-conservative in taking a firm stand.

The point has apparently now been reached when it will be impossible for manufacturers to delay much longer putting their quotations at higher levels generally. No sound business management will attempt to go to extremes in the matter of higher prices. Despite predictions to the contrary, it is generally realized there will be no run-away market this all, no shortage of merchandise. Conservative merchants know that the primary market improvement has not yet been duplicated in retail sales. They know that millions of men and women continue unemployed, and that additional millions are working only part time. They realize that recovery from a depression as severe as that of the last three years will come gradually and not over a few weeks or months, and they have no desire to choke off the impending increased flow of merchandise over the retail counter by arbitrarily advancing prices too sharply or too quickly.

NEEDED—PERSPECTIVE

THE Doubting Thomases are still with us, especially those who wonder where all of the goods now being made by the textile industry will find consumers with real purchasing power to buy these products. We believe that the basis for a strong revival of buying of textile products, especially, is definitely present today. Some typical examples may be cited to illustrate this point.

(1) Retail stocks today are at one of the lowest points in history. Inability to get spot delivery, plus rising prices of raw materials and finished goods, is precipitating a near-panic among retailers to stock their shelves at the present favorable price levels. It is estimated that if all retail textile stocks were replenished to a figure even near normal, this buying alone would run the textile mills of the country at their present accelerated rate for at least a one-month period.

(2) The commodity price level has remained stable or risen in the past eight weeks, depending on the index used. Specifically, the value of cotton on hand or to be picked has increased $400,000,000 in eight weeks, while the value of the hog crop has gained $175,000,000 in twelve weeks. (3) Savings bank deposits have risen some $700,000,000 in the past year. (4) The value of all securities in the United States has increased in value some $10,000,000,000 in the past eight weeks. (5) Federal Reserve member banks have approximately $250,000,000 of excess reserves available, which are capable of expansion into about $2,500,000,000 of bank credit.

(6) Hoarded money in this country (i.e., that money not used in trade) is not only the $1,000,000,000 difference between the August currency figures of 1929 and 1932, but probably nearer $2,000,000,000 because the physical volume of trade and the price level of 1932 are much lower than those of 1929. This two billion dollars could be drawn on quickly as purchasing power, with a further improvement in public psychology. (7) Many workers are being re-employed today in the textile industry, especially. In the rayon industry alone, after various shut-downs during June and July, it is probable that as many as 20,000 more people are on the payrolls today than was the case eight weeks ago. And more employment means more purchasing power.

We have elucidated factors here which total $15,800,000,000 of "new" purchasing power made available since the low point of these items in the depression, plus an additional full month's operation of all plants in the textile industry, plus substantially increased employment in

these plants. If some items are overstated or duplicated, these would easily be covered by increases in items which we have neither the time nor space to mention. The purchasing power to start business recovery is present, Mr. Doubting Thomas, and public psychology appears to be getting better every day.

We believe that the current activity in the textile industry is fully warranted, and, properly controlled by the manufacturers, this activity should increase and last well into the year 1933 at least.—*Textile Organon.*

Italian Dye Industry

According to the *Italian Exporter,* the dyestuff industry, already of considerable importance in Italy at the close of last century, attained its maximum development in the post-war years with the rise and success of the branch devoted to the production of those synthetic organic dyestuffs now so essential to the dye industry.

This rapid growth has not only made the home market almost entirely independent of foreign supplies, but has also allowed of a steadily growing export trade.

Synthetic Organic Dyestuffs and Intermediate Products

The manufacture of synthetic or tar dyes, as they are commonly called, only started in Italy after the close of the World War.

The raw materials used consist of aromatic hydrocarbons (benzol, phenol, tolulol, xilol, naphthaline, anthracene) from which by a series of processes of sulphuration, nitration, chlorination, evaporation, oxidation, etc., intermediate products are obtained which yield the whole gamut of colors.

These raw materials are partly imported and partly obtained by a more rational utilization of the coal imported for the gas and coke industries.

The leading intermediate products manufactured in Italy are aniline oils, of which 1.3 million kgs. are now produced, chlorobenzol which utilizes part of the chlorine obtained in the manufacture of electrolytic caustic soda, binitrochlorobenzol and binitrophenol obtained from chlorobenzol, hydrochloric acid, beta naphthol and benzidine obtained by an exclusively Italian process, paranitroanaline, tolidine, alpha naphthylamine, gamma acid, naphthoic acid and sulphanilic acid, naphthalic anhydride, anthraquinone, etc.

The most important Italian plants are those at Cengio (Savona), originally equipped for the manufacture of high explosives and subsequently adapted to the distillation of intermediate products and aniline oils, Cesano Maderno, and Rho, in the province of Milan.

According to the returns secured by the National Fascist Federation of the Chemical and Allied Industries the output of intermediate products in recent years has been as follows:

1928	7,100 metric tons
1929	7,400 metric tons
1930	7,000 metric tons
1931	6,500 metric tons

There is a steady average export of some 2,000 metric tons per annum.

The rapid growth of the intermediate product industry has been accompanied by a similar expansion in the manufacture of synthetic organic dyestuffs, some of which are already produced in quantities which leave a notable margin for export.

The Italian industry now produces most of the more important items for the whole series of synthetic dyes. The largest output, however, is that of sulphide dyestuffs, including black, which in recent years accounts for nearly 60% of all the synthetic dyes manufactured in Italy.

The manufacture of synthetic indigo started in 1926 at Cesano Maderno (Milan); that of navy blue and thyanthrene black, which followed in 1927 at Conca Fallata (Milan), marks the first important step forward in the manufacture of vat dyes.

There are only eight synthetic indigo factories in the whole world. The potential output of the Italian plant at Cesano Maderno, rising to nearly 6,000 kilograms of indigo in cakes, far exceeds the demand on the home market, estimated around 4 to 5 hundred thousand kilograms per annum. Consequently large quantities of synthetic indigo are exported to China, British India, and Japan.

On the other hand, the Italian output of dyes obtained from anthraquinone is still quite small.

Industrial Organization

Under the guild organization of the Italian State all producers of dyestuffs, pigments, mineral colors and paints are affiliated to the National Fascist Federation of Chemical and Allied Industries (Via delle Muratte, 43, Rome), which organizes them in two groups, one for synthetic organic dyes, and the other for mineral colors and paints.

Besides its syndical duties, the organization deals with the economic problems affecting the Italian dye and paint industries.

Markets

The chief consuming markets for Italian synthetic dyestuffs are British India, China, Japan, France, etc.

The following table gives the data for exports of synthetic dyestuffs in 1931 classified by countries of destination:

Italian Exports of Synthetic Dyestuffs in 1931

France	64.3	China	96.3
Greece	22.3	Japan	60.6
Portugal	37.8	British Indian and Ceylon	183.7
Rumania	11.5	Other countries	61.9
Spain	16.8		
Switzerland	26.1		
U.S.S.R.	....	Total, metric tons.	613.2
Brazil	10.3		

Enzyme Action in the Textile Industries

(Continued from page 554)

out that *aspergillus* is more common in warmer southern United States and *Penicillium* predominates in northern states); the effects of mildew; identification of mildew fungi; and gives a three-page table of "mould fungi" isolated from cotton goods, naming the species of *aspergillus* or *Penicillium,* giving the source, as for examples, cloth mildewed abroad, cloth mildewed in England, raw cotton (Queensland), yarn from Texas, etc. Indirectly it is of interest to students of enzymes. Mr. Galloway has written another interesting short paper[4] on mildew fungi in which "diamond-spot" stains are considered and some interesting experimental suggestions are made.

It has recently been suggested in discussions of occupational diseases that a peculiar cough occurring now and then among cotton weavers is caused by a mildew, and some species of *aspergillus* mold is presumed to be the most probable cause. The author suspects that careful investigation might show that it was an enzyme of the mildew that is the active excitant of the cough which might be aggravated by the presence of spores.

The examples cited thus far all have to do with fungi and enzymes that are active in starches, dextrines, etc., and have stressed cotton goods (textiles made from cellulose). Starches, dextrins and cellulose all belong to the polysaccharide division of the carbohydrates. They are easily hydrolyzed to water-soluble products with the exception of cellulose which investigations seem to show has a much more complex molecule than starch. The damage done to cotton goods for the greater part is due to staining by colored spores or conidia or mycelia. Tendering is probably in most cases due to the action of bacteria in connection with mold or alone. Bacteria do not grow on pure cellulose as nitrogen is required for their growth which is also required for the production of enzymes by molds. Most, if not all cotton goods, have enough other substances present to furnish starting points for enzymes. Mixed wool or silk and cotton goods contain the nitrogen bearing substances essential to the production of enzymes. Wool and silk are favorable on account of their higher hygroscopicity. However, it should be noted that for some reason silk goods do not seem to be affected by molds and bacteria to the extent that obtains in cotton or wool or their combinations. Woolen textiles damaged in storage and shipping by mildews have been studied from time to time to a limited extent but in a general way it may be said that the investigations were attempts at short cuts to remedies and as in similar investigations for cotton goods, did not undertake to find and study the basal factors.

The stimulus for research investigations in the textile industries is too often unusual economic losses. The unusual epidemic of mildew in woolen textiles in storage in England in the year 1928 may be looked upon as a starting point for a somewhat extensive and to some extent more scientific investigation of this trouble. Burgess[5] of the British Research Association for Woolen and Worsted Industries undertook to find a remedy for this condition. He points out at the beginning of the first paper that micro-organisms are involved and that control of moisture content, temperature and ventilation cannot be adequate to prevent their action and proceeds to investigate the value of antiseptics while indicating that there are more purely scientific aspects of the subject. He indicates in the first paper some of the conditions such as moisture, alkalinity, acidity, etc., that favor or prevent the growth and action of the molds and bacteria studied and points out that, as in the case of cotton goods, the molds (fungi), do their main damage by developing colors and mycelia and that tendering is usually, though not necessarily, due to bacterial growths. In the second paper he furnishes several tables of data relating to results of growth of species of *aspergillus* and *Penicillium* on woolen cloth treated with differing percentages of soap and oil based on the weight of wool and for the most part in 1 per cent aqueous solution and for different periods of incubation at around 75° F. (25° C.). The data indicate that soap and vegetable oils act to aid the growth of the fungi which he sums up in a sentence which in effect is that soaps, oils, etc., furnish energy and carbon and that wool furnishes nitrogen for the growth. Secretion of enzymes is mentioned in several places as indicating that they enter into the processes of growth but they are not given any detailed consideration such as the author believes they warrant or indeed necessitate if we are to get to the bottom of the problem. The paper closes in a brief discussion of prevention of mildew where it is pointed out that control of moisture, alkalinity and temperature in mill storage are the best precautionary measures but that antiseptics are best when the goods are to be shipped abroad and indicates that sodium silico fluoride is so far the only one that has given any real satisfaction for this purpose.

The author has mentioned that for some reason silk goods are not so much subject to damage from molds as

cotton and wool goods and shall leave the subject with that statement, but there is a field of possible practical application of the action of the proteases in silk manufacture that is worthy of further consideration.

Silk-wool unions are common in the industry. The silk in the gum is usually woven with the woolen or worsted yarns which necessitates the removal of the sericin before dyeing. This is usually done in the same way that is used in all-silk goods with the result that there is tendering of the wool yarns and a bleaching operation must be used when light shades are contemplated on account of the yellowish-brown cast given to the wool in the boil-off operation. The action of alkaline detergents on wool has been given attention from time to time for a number of years without careful consideration of the effect of temperature and pH value together and the tendering and browning were not very clearly explained. Mosher[6] has recently undertaken a fairly exhaustive study of the action of some commercial proteases in silk degumming on the assumption that these proteases might accomplish in a short period what had required a comparatively long time and unsanitary conditions in the primitive fermentation processes, and might not prove harmful to wool.

His first study was on pepsin degumming on which Johnson and Shelton had already made a quite extensive study and established that silk gum was composed of two proteins which they called sericin A and sericin B, the first being easily removed by pepsin digestion while the second was only slowly removed. Hydrochloric acid was used as activator for the pepsin which required degumming effect of the acid. This was found to be less than one per cent below 105° F. (40° C.), but at 120° F. (50° C.) it accounted for 5 per cent of the loss of sericin.

The optimum conditions were found to be: pH value, 1.8; exposure, at least four hours; persin concentration, ¼ per cent; and temperature, 105° F. (40° C.). Fortunately, the fibroin does not easily break down under these conditions so that the time element does not require careful control. Trypsin in which the activator is alkaline was examined with optimum conditions: pH value, 8.1 most favorable in practice; treated at least eight hours; temperature, 105° F. (40° C.); and trypsin concentration, ¼ per cent. The best activator was found to be a combination of ½ per cent sodium bicarbonate and 1/20 per cent sodium carbonate. Papain, one of the most active proteases and one of possible very low cost, is given careful examination but with negative practical result on account of the chemical character of the only two activators, hydrocyanic and hydrosulfuric acids, that gave high enough activation. Bromelin, a protease from pineapple, was examined and gave very much the same results as papain, being ruled out by the same poisonous activators.

Korofor and Serizyme, two proprietary enzymes of bacterial origin were studied and compared with each other and with other enzymes. The optimum conditions for Korofor were found to be: pH value, between 8 and 9; digested, at least eight hours; temperature 130° F. (54° C.); and concentration of Korofor, 2 per cent. Serizyme gave about the same optimum conditions as Korofor but was found to be more active than Korofor —Korofor discolored silk to some extent but Serizyme did not.

There was a considerable fraction of the silk gum remaining on the silk in all cases of enzyme degumming examined. No commercially successful way of removing this fraction of the gum was found that would not be somewhat detrimental to wool in silk-wool unions. Further studies of this problem are in progress which may in the near future lead to a commercially successful process for degumming the silk in silk-wool unions without injury to the wool.

The author has shown that enzymes are important factors in some investigations of textile problems that are of immediate economic interest to manufacturers of textile products and has briefly described attempts to find satisfactory solutions of the problems and may have left the impression that these are suggestive of the extent of the type of textile problems that may involve the study of enzymes in order to arrive at any complete understanding of them. I should not like to leave such an impression as I consider the study of enzymes and their actions of much more far-reaching value to textile industries than is indicated by these few problems. For example, improvement in textile raw material, which should always be of active interest to textile manufacturers, involves far-reaching studies of enzymes in the activities in food conversion and absorption, soil fertility, immunity from diseases, etc. A competent investigator for such intricate studies should be acquainted with the problems of the isolation and purification of enzymes and the very intricate procedures that have been used in attempts to control and determine specific enzyme actions in a way that can be formulated and repeated by other workers.

A quick introduction to this training may be obtained by first consulting a variety of modern books of the nature of advanced textbooks such as: Catalysis in Theory and Practice; Colloidal Chemistry; Physiological Chemistry; Microbiology; Bio-chemistry (theoretical and applied); Immuno-Chemistry; Chemistry of Plant Products; Fermentation; and others. All of these will have one or more chapters devoted to enzymes and will furnish many references to the literature of enzymes. Good textbooks entirely devoted to enzymes are available but should not be relied on to furnish all the information

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Change

Charles E. Maher, 620 Orleans St., Chicago, Illinois, dealer in dyestuffs and chemicals, has severed his connection with the Nyanza Color & Chemical Co. and is now the Mid-Western representative of the Onyx Oil & Chemical Co. of New Jersey.

Asbestos Textiles*

By **C. K. DILLINGHAM**

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This paper on asbestos textiles is a brief description of the occurrence and mining of asbestos fiber, its subsequent manufacture into asbestos textiles, and a brief outline of their characteristics and uses. No attempt has been made to go into technical details, but rather to present to those not familiar with the product a brief comparison between asbestos and other familiar textile fibers.

ASBESTOS, that remarkable mineral born millions of years ago in the volcanic fires of Earth's creation and formed under the terrific pressures that were set up as the crust of our planet began to cool off, has, as you all know, scores and hundreds of uses. Perhaps one of its most interesting adaptations has been its manufacture into asbestos textiles.

It is not commonly known that the use of asbestos textiles dates far back into ancient times. It was originally known as amianthus cloth and was used by the ancient Greeks and Romans to wrap dead bodies, placed on the funeral pyre, in order to preserve the ashes of the body. It was referred to in many an ancient document as a rare and costly cloth, the funeral dress of kings. Marco Polo, in the thirteenth Century, while traveling in Siberia, was shown cloth made from asbestos which the natives pointed to in wonder because it withstood the action of fire. Plutarch writes of his "perpetual lamp wick" made from Carpathian linen or asbestos.

Because of its ancient and modern place in the textile field, I believe some facts regarding asbestos and its adaptation in textile work will be of unusual interest. While asbestos in various forms occurs in all parts of the world, the general types in which textile manufacturers are interested are three in number, namely, chrysotile, represented by Canadian, Russian, and some kinds of African; the iron free, also chrysotile, represented by Arizona, Australian and one type of African; and the African brown and blue acid-resisting fibers. As Canadian asbestos is truly representative of the largest group and is probably the most widely known, this paper, because of its limited scope, should be considered as dealing only with Canadian chrysotile asbestos unless otherwise noted.

The asbestos fiber occurs as veins in serpentine rock, varying in width from almost nothing up to a rare maximum of 6 in. The fibers run across the vein so that the width of the vein is the length of fiber. Asbestos mining is in most cases really asbestos quarrying, as blasting is resorted to in order to loosen masses of rock in open pits after which the fiber is removed from the rock in varying ratios of about one ton of fiber to fifteen or twenty tons of material.

As soon as the blast has settled, the grading of the asbestos fiber begins. It is first divided into two main divisions, crude and mill fibers. The crude fiber is obtained by collecting the larger pieces of fiber shaken loose by the blast, and removing by hand the rock still clinging to it. It is then still further sorted according to length, but not with the degree of accuracy that is customary in the grading of cotton and wool, and is then packed in burlap bags and shipped to the point of consumption. The rest of the rock is then put through the mill at the mine, the rock crushed off, the fiber worked into a soft matted mass, screened, graded and packed as mill or milled fibers.

It is extremely difficult to grade or evaluate asbestos fiber as, with the exception of crude fiber, it is impossible to measure its length, and even if it were possible, the length of the fiber would not tell the story. In order, however, that there may be some specification or standard applicable to the many grades of mill fiber, the various asbestos mines have adopted a standard screen test by which mill fiber is classified into its many grades. The standard equipment consists of three screens and a pan placed one on top the other. The top screen is ½-in. mesh, the second screen is No. 4 mesh, the third screen is No. 10 mesh, with the pan at the bottom. A pound of fiber is placed on the top screen, and the apparatus is shaken by a cam having 600 revolutions in 2 minutes. After the 2-minute shaking, the amounts of fiber remaining on each screen and in the pan are carefully weighed, and the results given in ounces. Thus a fiber which is classified as a 2-8-4-2 fiber means that, after this shaking test, 2 oz. of fiber will remain on the top screen, 8 oz. on the second, 4 oz. on the third, and 2 oz. in the pan. While the results obtained by this method show considerable variation, it is a roughly accurate method of grading fiber. In the lower grades it determines the value of the fiber more or less accurately, as it does indicate its cleanliness, but in the higher grades, it takes no account of a quality of asbestos which is extremely important in textiles, packings, filter fibers, and possibly high-grade papers and insulations, namely, the natural life and resiliency of the fiber itself. Therefore, in the selection of fibers for textile purposes, to all the mechanical quality tests must be added knowledge of the workability of the different asbestos fibers obtained only through long experience.

*Presented at Annual Meeting, A. S. T. M.

In general we may say that the various grades of crude fibers and the two or three top grades of mill fibers can be used for the production of asbestos textiles. Some asbestos yarns require all crude fiber, due to the severe service to which they are put, others are made from a mixture of crude and mill fibers, while some of the cheaper grades of yarn and wick can be produced almost entirely from mill fiber. When crude fiber is used, the lumps of fiber as received from the mine are crushed and freed from all remaining rock. It is then passed through a willow which in general consists of two revolving beaters for the purpose of opening and fluffing up the fibers. As the mill fiber needs no further crushing, it is usually only fed through the willow. If crude and mill fiber are used they are usually mixed at the willow.

The next operation in the production of asbestos textiles is the mixing picker, and it is at this point that the grade or quality of the yarn is determined by the mixture of a certain quantity of vegetable fiber, usually cotton, with the asbestos. Cotton is used to reduce the cost of asbestos yarn to commercial limits. Its great carrying power makes it possible to produce a stronger asbestos yarn from low-grade asbestos or from a higher-grade asbestos with less waste than without it, and as there is very little necessity for an all-asbestos yarn, varying amounts of cotton will be found in practically 98 per cent of asbestos textiles. The mixing picker used in asbestos is usually of the heavy Fearnaught type quite unlike the cotton picker or lapper.

In carding, spinning and twisting asbestos yarns special equipment of heavier, more rugged construction must be used than in the case of other textile fibers, but in designs and methods asbestos machines more nearly follow the woolen system than any other. It is quite common in the industry to use a breaker and finisher card hooked together by means of a so-called camel-back feed. The asbestos and cotton mixture is delivered to the breaker card by means of a feed box, automatically weighing out a predetermined amount of mix at set intervals. Asbestos roving without twist is commonly taken from the finisher card by means of a ring doffer, wipe roll and rub motion, although in the case of some of the finer yarns tape condensers replace the ring doffer and wipe roll.

The asbestos roving delivered by the card is spun into yarn by two methods, namely, mule and ring, both producing yarn by the same principle, that is by twisting the soft roving on its own axis, thereby binding the fibrous mass into a strong compact thread, where formerly it had very little cohesive strength. In the main, mule spinning is used to produce a softer, more pliable single yarn to be later twisted into a plied yarn while ring spinning is used to produce a harder twisted stronger yarn which can be used in the single on braiders and winders in packings, and in the weaving of fine cloths and tapes. Draft as understood in cotton spinning is not used.

The spun yarn is spooled up and prepared for the twister in the same manner as is commonly found in the manufacturing processes of other textile fibers. An asbestos yarn twister, with the exception of its size and weight, is of the same general type as used in cotton and wool. Asbestos yarns are twisted into ply yarns in the same manner as other yarns, with the addition that a large amount of asbestos yarn has one or more strands of brass or copper wire twisted with a varying number of asbestos plies into what is known as wire-inserted asbestos yarn. This name is derived from the fact that wire strands tend to twist towards the center of the yarn.

Asbestos yarns and roving are produced and sold by size or cut and not by diameter. The size or cut of the yarn means the number of 100 yd. to the pound of the single- or one-ply yarn. Thus a 10-cut yarn or roving will average 1000 yd. per pound. Although asbestos has been spun into yarns as fine as 70's the commercial sizes run from 8's to 20's, as there is very little call for the higher counts. With a few exceptions the count or cut jumps 200 yd. at a time as for example 8's, 10's and 12's, because asbestos yarn due to its mineral raw material is recognized as varying considerably in yardage. Tolerances for 14's and finer are accepted as being ± 100 yd., from the count and ± 50 yd., for lower counts. It would therefore be rather difficult to determine intermediate cuts or counts as their yardages would at times overlap.

As ply yarns are made by twisting together two or more strands of single yarn whose yardage has already been determined, it is evident that the yardage of a ply yarn will be the yardage of the single yarn divided by the number of plies, less a certain amount for the contraction caused by the twist. Thus a 10-cut 2-ply yarn would have a yardage of 1000 divided by 2 less 40 or approximately 460. As a rule, the yardage of a 2-ply yarn is about 46 per cent of the single ply. If wire is inserted in the yarn its weight also reduces the yardage of the ply yarn, as here again the size of the single-ply asbestos yarn is the governing factor. A wire-inserted asbestos yarn containing three plies of 10-cut yarn and 2 wires is known as a 10-cut 3-ply wire-inserted yarn and can be written as 10/3 and 2 or in common mill parlance 1032. If the asbestos strands are 10-cut yarn and no other specifications as to size and percentage of wire or weight of finished yarn have been especially agreed upon, the mill has made a good delivery.

The five generally recognized qualities or grades of asbestos yarns are outlined in the Society's proposed revised Specifications for Tolerances and Test Methods for Asbestos Yarn (D 299-29) as follows: Grade A-1, a minimum of 77 per cent asbestos; grade A, 80 to 85 per cent; grade AA, 90 to 92 per cent; grade AAA, 95 to 96 per cent; and grade AAAA, all asbestos with a trace usually about 1 per cent of foreign matter permitted. These grades are the result of years of experience in producing asbestos textile to meet all requirements of industry as cheaply as possible, and in addition to covering all necessary qualities enable the manufacturers to utilize in the lowest grades a part of the waste

produced in the higher grades. The grade or quality of a wire-inserted asbestos yarn is determined by the grade of the asbestos strands in the yarn, no account whatever being taken of the wire. All tests are made with the wire removed.

A visitor to the weaving room of an asbestos textile mill would probably see the greatest collection of equipment ever brought together in a single textile department. Here asbestos textile fabrics are woven in widths varying from ½ to 124 in., in thicknesses from 0.015 to more than 1 in., in textures from 6 ends per inch to more than 100, and in weights from ½ lb. per sq. yd. to 6 lb. per sq. ft. For cloths, various of the common types of fly shuttle looms are used together with some special looms of heavier construction. Asbestos brake linings and asbestos tapes are woven on multiple-shuttle, narrow-fabric looms. Both creel and beam weaving are employed depending on circumstances. In cloths the plain and common twill weaves are the most usual while in brake linings various ply weaves are used. All sizes and grades of asbestos yarns are woven into fabrics.

Asbestos is commonly called fireproof, but a better term would be fire resistant. A sufficiently high temperature can eventually destroy almost everything known and asbestos is no exception. The breakdown of asbestos under heat depends entirely upon the loss of its water of hydration, of which chrysotile asbestos has an average of 14 per cent. The water of hydration begins to leave asbestos just above 600° F. (315° C.) but only at a very slow rate. At 1000° F. (540° C.) about one-fourth of it has been driven off, but at this point it begins to go more rapidly so that above 1200° F. (650° C.) it will quickly disappear entirely. After the water of hydration has been driven off the fiber becomes completely calcined and can be crushed to a powder. The length of time during which the fiber is subjected to a given temperature has very little effect, the temperature itself being the important factor.

Asbestos has also been called an insulator against heat. This is also slightly erroneous. Asbestos in solid form is not an insulator but will transmit heat. When woven into a fabric its insulating qualities are almost negligible if applied directly to the source of heat. As an example, a piece of asbestos cloth laid on a metal plate having a temperature of 900° F. (480° C.) reduced the temperature above the cloth only 35° F. (19° C.). However asbestos in cloth or other forms does furnish a strong heat-resisting medium around which insulation in the form of enclosed air spaces, for instance, can be built.

In order to give the reader some idea of the temperatures which the various grades of asbestos textiles will safely stand, the following may be stated as a general rule: grade A-1 and grade A, 350 to 400° F. (175 to 205° C.); grade AA, 600° F. (315° C.); grade AAA, 850° F. (455° C.); and grade AAAA, 950° F. (510° C.). These figures must be considered as applying to plain asbestos yarns and cloths without impregnation coating, or treatment of any kind. Special severe conditions may reduce these limits, and, reversely, ideal conditions of service may greatly increase them.

Reference was made previously to iron-free and acid-resisting asbestos fibers. In most chrysotile asbestos, iron is found in both ferrous oxide Fe_2O_3 and free magnetic iron Fe_3O_4. In some cases where asbestos is used as an insulting wall on electrical wires, the free magnetic iron is objectionable, and for this work a fiber, such as Arizona, Australian, and one type of African, which is free from this form of iron, must be used.

With the exception of the brown and blue African fibers, asbestos is attacked by acids in about the same degree as cotton fibers. From a commercial standpoint weak acids seem to have more effect on the fiber than concentrated acids, except under boiling temperatures, where the action is much increased. In strong hot acid solutions chrysotile asbestos will lose over 50 per cent of its weight. Blue African asbestos stands snpreme in acid resistance with a maximum loss of approximately 20 per cent, and the brown African amosite ranks second. Alkalies at ordinary temperatures, up to 20 per cent strength, have no effect on asbestos, and very little effect beyond that.

The chief outlet for asbestos textiles today is as the raw material for the manufacture of other products such as brake linings and packings, but there is an ever-growing market for asbestos yarns, cloths, and tapes in their primary form to be found in their use on insulated wires, gloves, clothing, theatre curtains, filters, conveyor belts, etc. In fact, wherever a soft, pliable, yet strong heat-resisting medium is needed there is a market for asbestos textiles.

For centuries asbestos was but a curiosity, a mystic mineral. Today, with its possibilities for being spun, woven, felted or molded into useful form, it is a recognized necessity in our modern-day world.

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needed. A liberal laboratory training should accompany the use of textbooks and takes not weeks and months but years, which suggests that the younger generation of biochemists should be the ones to prepare for such broad investigations in the hope that a few years hence they will be needed in the textile laboratories.

References

[1] R. G. Fargher and L. V. Lecomber, "The Determination of Starch in Sized and Finished Cotton Goods," *Journal*, Textile Inst., October, 1931.

[2] George Smith, "The Identification of Fungi Causing Mildew in Cotton Goods: The Genus Aspergillus," *Journal*, Textile Inst., March, 1928; February, 1931.

[3] L. D. Galloway, "The Fungi Causing Mildew in Cotton Goods," *Journal*, Textile Inst., June, 1930.

[4] L. D. Galloway, "The Formation of 'Diamond-Spot' Stains by Mildew Fungi," *Journal*, Textile Inst., October, 1931.

[5] R. Burgess, "A Contribution to the Microbiology of Wool," *Journal*, Textile Inst., T315 (1928); also "Further Studies on the Microbiology of Wool—The Enhancement of 'Mildew' by Soaps and Vegetable Oils," *Journal*, Textile Inst., T333 (1929).

[6] H. H. Mosher, "Enzymes as Silk Degumming Agents," *American Silk Journal*, August, September and October, 1931.

Courses of Instruction

Courses on the following subjects will be offered at Columbia University in the evening division:

Spinning and Weaving of Cotton Yarns and Grey Goods. The first lecture will be given Friday, September 30, Room 410, School of Mines, 116th Street and Broadway, from 7:30 to 9:20 P. M.

Manufacture, Weaving and Converting of Rayon and Other Synthetic Yarns and Piece Goods. The first lecture will be given Thursday, September 29, Room 410, School of Mines, from 7:30 to 9:20 P. M.

The instructor in the above courses is Herbert R. Mauersberger, B.T.E., graduate of the Lowell Textile Institute, and formerly with Cox, Fuller & Mauersberger, Consulting Textile Specialists, and the Celanese Corporation of America.

Design for Textiles. The first lecture will be given Wednesday, October 5th, from 7:30 to 9:20 P. M., Room 614, School of Engineering. The instructor is William H. Arlt, formerly with U. S. Finishing Co., Arnold Print Works, Passaic Print Works and Armory, Brown & Co.

A course on *Textile Engineering and Silk Instruction* will be given at the Packard School, Lexington Avenue and Thirty-fifth Street, New York City. It will be conducted by Rudolph D. Muller, Head of the Department of the Paterson Vocational School and President of the Textile Research Society. Classes will be held on Thursday evenings from 7 to 9 P. M., starting Thursday, Sept. 29th.

Du Pont Exhibit

A new development by which cotton fibers are chemically treated so that the fibers curl, producing a permanent wool-like texture, was demonstrated by a recent display of the Bellman Brook Bleachery in one of the Boardwalk windows at the Du Pont Exhibit, Atlantic City, N. J.

Swiss Output Drops

Swiss silk and rayon weaving establishments are reported working at only about 50 per cent of capacity. In 1929, the latest census year, there were 79 such firms, employing 12,557 workers, according to a report by the Bureau of Foreign and Domestic Commerce of the United States Department of Commerce. At present, thousands of looms are standing idle, and the number of workers has been reduced at least 2,500. Some plants have suspended operations.

Notwithstanding heavy declines in exports of silk goods and increased imports, the Zurich Silk Industry Union, nevertheless, believes that as soon as normal conditions return, the idle looms will be set in motion and also that the accumulated stocks, made of raw material bought when prices were exceptionally low, may bring a good profit later.

The report of the Union adds, however, that Switzerland will be able to compete successfully in foreign markets only if cheaper production costs can be attained.

The rate for "Position Wanted" advertisements in this column is 2 cents a word—with a minimum of 50 cents per insertion. For all other types of advertisements—i.e., help wanted, machinery or supplies for sale—the rate is $5.00 per column inch or less per insertion.

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